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ABSTRACT

Introduction Maintaining good health with advancing age is increasingly important as most European countries experience an increase in retirement age. In order to decrease the risk of premature departure from the workforce, identifying groups at increased risk of musculoskeletal pain and psychosocial stress is essential in designing workplace policies. Therefore, the aim of this study was to investigate the relationship between occupational groups differing in terms of physical demands and skill requirement, and the outcomes of stress and pain.

Methods This cross-sectional study reports associations of nine different occupational groups with stress and pain among 11 474 senior workers; stratified by occupational group and based on the International Standard Classification of Occupations (ISCO). A large-scale questionnaire survey was dispatched to Danish workers; drawn as a probability sample and merged with national registers. Representative estimates were produced using logistic regression controlling for various confounders, combined with model-assisted weights.

Results The prevalence of daily pain and high stress among occupational groups ranged between 20.0%–50.5% and 3.9%–10.0%, respectively. Compared with occupations characterised by being mostly sedentary (ISCO group 1–4), those with primarily physical demanding work (ISCO group 5–9) had higher odds of daily pain (OR 1.53, 95% CI 1.37 to 1.70) and a tendency towards higher stress scores (OR 1.20, 95% CI 0.98 to 1.46). Lastly, female workers experience increased odds of daily pain (OR 1.50, 95% CI 1.35 to 1.66) and high stress (OR 1.56, 95% CI 1.29 to 1.89) compared with male workers.

Conclusions Occupational settings characterised by mainly physical work and low skill requirements are more likely to experience daily pain compared with those entailing mainly sedentary work. Likewise, in this sample of senior workers, women are more likely to experience pain and stress. These results highlights the need for improving occupation-specific and sex-specific guidelines in the prevention of musculoskeletal pain and psychological stress in workplaces.

Trial registration number ClinicalTrials identifier: NCT03634410

INTRODUCTION

The study of stress has more than 50 years of experience; most notably influenced by

Strengths and limitations of this study

- This cross-sectional study includes more than 11 000 senior workers from nine different occupational settings with varying degrees of physical work and skill requirements.
- Based on questionnaire data, a large-scale probability sample was used.
- Merging the study sample with high-quality national registers, the analyses included senior workers who answered questions related to musculoskeletal pain and psychosocial stress.
- Using these methods and subsequently using the International Standard Classification of Occupations, the prevalence of daily pain and high stress among the different occupational groups are quantified.
- Limitations include the risk of recall, non-response and common-method bias associated with survey studies, as well as the dichotomised outcome for psychosocial stress.

epidemiological, psychological and biological research traditions.¹ Historically, the epidemiological approach seeks to identify and assess objective stressors; induced by specific events and numerically cumulative in nature, which laid the foundation for the development of ‘early stressful life event’ scales.² Contrastingly, the biological approach—influenced by early work in experimental psychophysiology³—uses physiological measures of stress (cortisol, epinephrine, norepinephrine etc.) to objectively assess the systemic impact of a given stressor.⁴ Lastly, the psychological approach accentuates the individuals’ perception and response to stressful events; highlighting the observation that a stressful experience can neither be uniformly identified nor quantified.⁵

Emphasising the latter approach, the notorious phenomenon of psychosocial stress can be defined as the response to (real or perceived) environmental demands, threats

and challenges exceeding the adaptative capacity of the individual.^{6,7} Factually, prolonged stress is associated with a plethora of negative health outcomes, ranging from depression and anxiety⁸ to type 2 diabetes and persistent pain^{9–11}; the latter of which represents a growing issue among the general working population.^{12–14}

Specifically, while occupational stress has been identified as a potent risk factor for various pain conditions,^{15–18} little is known about predictors of poor health related to inherently different job groups. Additionally, especially in senior workers, few studies have investigated differences between different occupational settings and the outcome of psychosocial stress. However, in a sample of 571 blue-collar and white-collar workers, Dédèlè *et al* found that blue-collar workers were more likely to experience high stress, whereas—within the group of white-collars—sedentary time was associated with increased odds of high stress.¹⁹ Therefore, while the common notion dictates that occupations characterised by high physical demands are less likely to (also) experience stress, it is evident that important nuances exist. Additionally, while the literature lacks a clear consensus regarding sex differences in occupational stress,^{19,20} it is not unlikely that potential differences are either mediated or moderated by several factors²⁰; including characteristics of the specific occupational setting.

Furthermore, while the vast majority of research on risk factors related to the work environment has been performed on younger individuals,^{21–24} senior workers are likely to be experiencing additional stressors related to increasing retirement age and barriers for prolonging work life.²⁵ Indeed, while musculoskeletal pain constitutes a potent risk factor for long-term sickness absence among blue-collar and white-collar workers alike,²⁶ older age is independently associated with persistent pain^{27,28} and psychosocial stress.¹⁹

Thus, whereas a plenitude of studies report a high prevalence of musculoskeletal pain among workers with demanding physical work,^{21,29,30} the relationship between stress and factors inherently related to different occupational settings is unclear.

Therefore, by applying validated measures of psychosocial stress and musculoskeletal pain to a large cohort of Danish senior workers, this study sought to investigate the relationship between occupational groups with different physical demands and skill requirements, and levels of stress and pain.

METHODS

Study design

Using a cross-sectional study design, this study reports associations between inherent work characteristics and odds of high stress (primary outcome) and daily pain (secondary outcome) among different occupational groups. A large-scale questionnaire survey was dispatched in July 2018 to a total of 30 000 Danes above the age of 50, drawn as a probability sample by Statistics Denmark and

merged with national registers through social security numbers.³¹ For the present analyses, currently-employed workers belonging to the International Standard Classification of Occupations (ISCO) groups 1–9 and who answered questions related to stress and pain were included; yielding a total sample size of 11 474 employed senior workers.

Study population

Based on national registers and self-reporting, age, height, body mass, smoking status, working hours and level of physical activity during work, were included as descriptive variables. For example, the number of working hours and levels of work-related physical activity were quantified by the questions ‘how many hours do you normally work per week?’ and ‘how would you describe your level of physical activity in your current work?’, respectively. [Table 1](#) shows the demographics of the included sample.

Using national registers, the survey-respondents were stratified into nine occupational groups based on the official Danish version of the ISCO.³² Dividing the Danish labour market into occupational subgroups according to job tasks, work function and skill requirement, the ISCO is structured as a six-digit, five-level classification system. The present study includes the following first-level ISCO groups: (1) managers (levels III and IV skill requirement), (2) professionals (level IV), (3) technicians and associate professionals (level III), (4) clerical support workers (level II), (5) services and sales workers (level II), (6) skilled agricultural, forestry and fishery workers (level II), (7) craft and related trades workers (level II), (8) plant and machine operators and assemblers (level II) and (9) elementary occupations (level I). Due to a low number of observations, ISCO group 0 (armed forces occupations) was excluded from the present analyses. Likewise, while this study dichotomises the ISCO groups into occupations consisting of (a) group 1–4 (mainly sedentary work and high skill requirement) and (b) group 5–9 (mainly physical work and low skill requirement), we have previously published results from the nine individual groups in a supplementary appendix.²⁵ Further, three items related to the psychosocial work environment were included as descriptive variables (ie, decision latitude, work/life balance and recognition from colleagues). For example, ‘decision latitude’ constitutes the combined ratings to the questions ‘how often do you influence how you solve your work tasks?’ and ‘how often do you influence when you solve your work tasks?’. These questions were answered on a 5-point Likert scale (ranging from ‘never’ to ‘always’ and converted to a 0–100 scale (ie, poor; 0–50, moderate; 50–70 and good; 75–100), in order to better quantify differences within variables ([table 1](#)).

Outcomes

Using Cohen’s Perceived Stress Scale (CPSS), with each of the 10 items rated on the 5-point Likert scale (ranging from ‘never’ to ‘almost always’), the participants were assigned individual stress scores. CPSS is a widely-used

Table 1 Demographics, lifestyle, health and ISCO groupings

	ISCO 1–4		ISCO 5–9	
	Males	Females	Males	Females
N	3498	3899	2600	1477
Age (years)	56.9 (5.8)	56.2 (4.9)	56.9 (5.5)	56.2 (4.5)
Height (cm)	181.3 (7.4)	168.1 (6.5)	179.7 (7.9)	166.6 (7.1)
Body mass (kg)	87.6 (15.5)	71.8 (15.8)	88.7 (17.5)	72.2 (17.3)
Working hours/week	41.0 (9.1)	37.3 (7.6)	39.1 (10.1)	35.0 (7.4)
Smoking (% yes)	14 (13 to 15)	14 (13 to 16)	26 (24 to 28)	26 (24 to 29)
Psychosocial variables (0–100)				
Decision latitude	80.1 (21.0)	76.7 (21.2)	75.7 (26.1)	73.0 (26.9)
Recognition from colleagues	76.8 (21.1)	76.0 (20.7)	76.9 (24.2)	76.7 (23.8)
Work/life balance	52.2 (22.8)	50.6 (22.6)	55.4 (25.5)	53.4 (25.7)
Frequency of pain within the previous 3 months (%)				
Daily	17.1	24.9	28.6	30.6
Not daily	82.9	75.1	71.4	69.4
Cohen's Perceived Stress Scale score (%)				
Low/moderate stress (0–20)	95.6	92.9	94.5	91.4
High stress (20–40)	4.4	7.1	5.5	8.6
Level of physical activity at work (%)				
Sedentary	70 (68 to 71)	63 (62 to 65)	19 (17 to 21)	10 (8 to 12)
Standing or walking	21 (20 to 23)	26 (24 to 28)	24 (22 to 26)	23 (20 to 25)
Standing or walking with a lot of lifting or carrying	8 (7 to 9)	9 (8 to 10)	43 (40 to 45)	52 (49 to 55)
Heavy or fast work that is physically strenuous	1 (1 to 2)	1 (1 to 2)	14 (12 to 16)	15 (13 to 17)

ISCO 1–4; mainly sedentary work, ISCO 5–9; mainly physical work (n=11 474).

All items, including level of physical activity, are based on self-reporting.

Values are presented as either percentage (95% CI) or mean (SD).

ISCO, International Standard Classification of Occupations.

instrument for classification of the subjective measuring of perceived stress, with questions related to thoughts and feelings regarding one's own situation within the previous 4 weeks.^{23 33 34} In the general population, normative values (mean (SD)) are 12.1 (5.9) and 13.7 (6.6) for men and women, respectively, and scores >20 are considered high.³⁵ In the present analyses, the summed score was dichotomised with scores 0–20 and >20 indicative of low-moderate and high stress, respectively.

In the same survey, frequency of musculoskeletal pain was quantified by the question: 'Within the previous 3 months, how often have you experienced pain?', with possible response-options of 'daily', 'one or several times per week', 'a couple of times per month', 'rarely' and 'never'. In the present analyses, a dichotomised categorisation ('daily pain' and 'not daily pain') was used.

Statistics

SURVEYFREQ procedure was used to produce estimates of prevalences and 95% CI. The SURVEYLOGISTIC procedure (SAS, V.9.4) was used to model ORs and CIs for having daily pain and high stress, respectively. For ISCO, groups 1–4 were used as reference, that is, ORs for

groups 5–9. For sex, males were used as reference, that is, ORs for females are presented. Sex, occupational group and age were entered in the statistical model simultaneously, that is, they were mutually adjusted. As a supplemental analysis, we combined stress (low/high) and pain (not daily/daily) into four categories, using the combination of 'not daily pain/low stress' as reference. The SURVEYLOGISTIC procedure was used to run a multinomial logistic regression.

Model-assisted weights were used to make estimates representative of Danish workers above the age of 50. These weights were used for both the SURVEYFREQ and SURVEYLOGISTIC procedures and were based on information from high-quality national registers at Statistics Denmark, and took into account sex, age, occupational industry, highest completed education, family income, family type and origin.

RESULTS

Table 1 shows descriptive variables of the study participants. Of note, the included descriptive psychosocial

Table 2 Prevalence of daily pain and high stress among ISCO groups

ISCO group	N	Daily pain (%)	High stress (%)
1. Managers	811	20.0	3.9
2. Professionals	3267	26.7	6.3
3. Technicians and associate professionals	1642	28.5	6.5
4. Clerical support workers	1106	30.3	7.0
5. Services and sales workers	1258	37.5	7.3
6. Skilled agricultural, forestry and fishery workers	162	29.6	5.2
7. Craft and related trades workers	805	43.0	5.7
8. Plant and machine operators and assemblers	638	40.0	5.1
9. Elementary occupations	837	50.5	10.0

ISCO, International Standard Classification of Occupations.

variables show relatively small differences between sex and dichotomised ISCO groups. Additionally, the unadjusted prevalence for the category 'daily pain/high stress' were 1.5% and 3.1% for men and women, respectively, in ISCO groups 1–4, while the prevalence for the same category were 2.8% and 5.1%, respectively, in ISCO groups 5–9.

This study reports the prevalence of daily pain and high stress among various occupational groups; ranging from 20.0% to 50.5% and 3.9% to 10.0%, respectively. Of note, managers (ISCO group 1, n=811) experience the lowest prevalence of both daily pain (20.0%) and high stress (3.9%), while workers in elementary occupations (ISCO group 9, n=837) show the highest prevalence (50.5% and 10.0%, respectively). The remaining ISCO groups show smaller variation in terms of these outcomes (ie, ranging from 5.1% to 7.3% and 26.7% to 40.0% for 'high stress' and 'daily pain', respectively; [table 2](#)). [Table 3](#) shows descriptive differences between men and women from the included occupations.

Associations between ISCO groups (1–4 vs 5–9), sex and the ORs for experiencing daily pain and high stress are shown in [table 4](#): With ISCO groups 1–4 as reference, ORs of 1.53 (95% CI 1.37 to 1.70) and 1.20 (95% CI 0.98 to 1.46) for daily pain and high stress, respectively, are observed for ISCO groups 5–9. Additionally, female workers experience increased odds of daily pain (OR 1.50, 95% CI 1.35 to 1.66) and high stress (OR 1.56, 95% CI 1.29 to 1.89), compared with male workers across all occupational groups. Of note, the Spearman correlation coefficient between stress and pain was 0.26 ($p<0.0001$). Further, [table 4](#) include interactions between sex and dichotomised ISCO groups, showing significant interactions for the outcome of 'daily pain' but not for 'high stress' ($p=0.01$ and $p=0.88$, respectively).

[Table 5](#) shows the combinations of stress and pain categories and associated ORs; that is, four categories including 'not daily pain/low stress' as reference. Compared with ISCO groups 1–4, groups 5–9 show ORs of 1.00 (95% CI 0.77 to 1.31), 1.49 (95% CI 1.33 to 1.67) and 1.84 (95% CI 1.39 to 2.45) for the categories of 'not

daily pain/high stress', 'daily pain/low stress' and 'daily pain/high stress', respectively. Likewise, women exhibit ORs of 1.35 (95% CI 1.05 to 1.73), 1.44 (95% CI 1.29 to 1.61) and 2.30 (95% CI 1.72 to 3.08), respectively, compared with men.

DISCUSSION

The results of the present study provide associations between occupational groups (ISCO 1–4 vs 5–9) and odds of high stress and daily pain. Specifically, groups

Table 3 Prevalence of daily pain and high stress among men and women from different occupations

ISCO group	Sex	Daily pain (%)	High stress (%)
1. Managers	M	17.2	3.7
	F	27.6	4.2
2. Professionals	M	19.1	4.8
	F	34.3	7.7
3. Technicians and associate professionals	M	25.5	3.9
	F	31.6	9.3
4. Clerical support workers	M	21.7	7.3
	F	33.7	6.9
5. Services and sales workers	M	31.3	4.7
	F	41.2	8.8
6. Skilled agricultural, forestry and fishery workers	M	32.2	4.1
	F	20.7	9.7
7. Craft and related trades workers	M	43.9	5.6
	F	31.7	6.3
8. Plant and machine operators and assemblers	M	37.9	5.4
	F	49.4	3.6
9. Elementary occupations	M	47.3	7.9
	F	56.8	14.1

F, female; M, male.

Table 4 Odds of experiencing daily pain and high stress related to dichotomised occupational groups and sex

Variable	Daily pain		High stress	
	OR	95% CI	OR	95% CI
ISCO 1–4	1		1	
ISCO 5–9	1.53	1.37 to 1.70	1.20	0.98 to 1.46
Male	1		1	
Female	1.50	1.35 to 1.66	1.56	1.29 to 1.89
Interaction sex*ISCO	p=0.01		p=0.88	
ISCO 1–4				
Males	1			
Females	1.68	1.47 to 1.92		
ISCO 5–9				
Males	1			
Females	1.27	1.07 to 1.51		

Interactions between sex and ISCO groups are included.

Values are presented as ORs and 95% CIs.

Mutually adjusted for occupational industry, sex and age, and weighted for sex, age, occupational industry, highest completed education, family income, family type and origin.

Sex*ISCO interacted for the odds of having daily pain (p=0.01), but not for having high stress (p=0.88). Therefore, an additional analysis, accounting for this interaction, was performed for women versus men within ISCO groupings.

ISCO, International Standard Classification of Occupations.

belonging to ISCO 5–9 (mainly physical work and lower skill-requirement) show significantly higher odds of experiencing daily pain compared with ISCO groups 1–4 (mainly sedentary work and higher skill-requirement). Furthermore, women showed higher odds of both high stress and daily pain in the dichotomised model, with the interactions between sex and ISCO groups highlighting the importance of taking the specific occupational setting into account when investigating sex differences; most notably for the outcome of musculoskeletal pain.

Interestingly—and perhaps in contrast to commonly-held beliefs—when dichotomising occupational groups according to physical work and skill requirements, no significant difference is observed for the outcome of high stress. However, given the numerical value of 1.2 and relatively wide CIs, it is not unlikely that a larger sample size would result in statistical differences. Nevertheless,

the main result is predominantly underscored when (descriptively) excluding the two extremes (ISCO groups 1 and 9), for which the differences for both outcomes are exceedingly pronounced. Indeed, previous research confirms that psychosocial stress is not limited to a select few, but found far and wide among very different occupational settings.^{14 36–41} This is in contrast to the outcome of pain, where—in line with the results from the present study—strong associations are found between occupations entailing high physical workload and the risk of musculoskeletal pain.^{21 42 43} Here, we show that ISCO groups 5–9 exhibit 50% higher odds of daily pain compared with ISCO groups 1–4, with more than half of the workers in elementary occupations belonging to this category. Therefore, whereas the prevalence of pain seems disproportionately matched between occupational groups, levels of psychosocial stress are likely somewhat

Table 5 Combinations of pain and stress categories and associated ORs for ISCO groups and sex

Variable	Not daily pain/high stress		Daily pain/low stress		Daily pain/high stress	
	OR	95% CI	OR	95% CI	OR	95% CI
ISCO 1–4	1		1		1	
ISCO 5–9	1.00	0.77 to 1.31	1.49	1.33 to 1.67	1.84	1.39 to 2.45
Male	1		1		1	
Female	1.35	1.05 to 1.73	1.44	1.29 to 1.61	2.30	1.72 to 3.08

Mutually adjusted for occupational industry, sex and age, and weighted for sex, age, occupational industry, highest completed education, family income, family type and origin.

The category of 'not daily pain/low stress' was used as reference.

The Spearman correlation coefficient between stress and pain was 0.26 (p<0.0001).

Values are presented as ORs and 95% CIs.

ISCO, International Standard Classification of Occupations.

similar across occupations with varying physical demands and skill requirements.

Perhaps more importantly, the results presented in [table 5](#) emphasise the significance of not only addressing these outcomes separately, but indeed in combination. Specifically, ISCO groups 5–9 and women experience significantly higher odds of ‘daily pain/high stress’ compared with ISCO groups 1–4 and men, respectively. In addition to emphasising the mediating effect of factors related to specific work environments, these findings highlight the importance of addressing the comorbidity of stress and pain, and underscores the notion that these are bi-directionally intertwined.^{44–46}

In line with this notion and considering the fact that an extensive range of physical, organisational, situational and psychosocial aspects of the working environment have been identified as potent risk factors for both musculoskeletal pain^{47–50} and psychosocial stress,^{51–53} it seems unsurprising that the majority of occupational groups struggle with these health-related issues. Indeed, referring to Cooper and Marshall’s original model of occupational stress and the five primary sources of stress at work (organisational structure and climate, relationships at work, career development, role in the organisation and aspects intrinsic to job tasks),⁵⁴ this degree of commonality between work-related stress factors appears well-founded in theory. Therefore, although a few select working environments may be more susceptible to the effects of inherent stressors than others, it is likely that the outcome of occupational stress does not share the same differentiation as that of musculoskeletal pain. Focusing on seniors, who constitute a group of the work force increasingly susceptible to musculoskeletal pain,^{27 28 55} it seems vital to implement preventative strategies that target this population with the aim of decreasing barriers for a long and healthy work life.⁵⁶

Finally, the present study—counting more than 11 000 workers—reports notable differences between sexes, with women exhibiting increased odds of both daily pain and high stress. As inferred from [table 5](#), these sex differences seem even more pronounced as the combination of comorbidity develops from ‘no daily pain/low stress’ to ‘daily pain/high stress’ in a dose-response manner; with women experiencing more than twice the odds of belonging to the latter category compared with men.

Whereas biological sex differences related to the experience of pain are fairly established in scientific literature,⁵⁷ the outcome of occupational stress exhibits mixed findings.^{20 58–60} For example, while some studies report different sources and levels of occupational stress between men and women,^{58 60 61} others either find no dissimilarities⁵⁹ or that controlling for relevant confounders (eg, marital status, age and education) attenuates these differences.²⁰ Therefore, backed by findings on qualitative differences in types of stressors and associated coping behaviour observed between men and women,^{61 62} the results presented herein add strong evidence to the notion that, across most occupational groups, sex differences

are observed for the outcomes of both musculoskeletal pain and psychosocial stress. However, as is evident from the interaction presented in [table 4](#), the type of occupational setting likely plays a mediating role in the observed differences for the outcome of pain. Likewise, as shown in [table 1](#), it is worth noting that women—in both ISCO groupings—report less sedentary time during work than their male counterparts, which might be an important mediator of both outcomes. Collectively, these results highlight the notion of addressing sex-specific risk factors inherent to the local work environment.

Strengths and limitations

Limitations include the risk of recall, non-response and common-method bias inherent to questionnaire surveys.^{63–65} However, as the probability sample among all eligible Danish residents above the age of 50 was merged with national registers through social security numbers, it is highly likely that the presented estimates are representative of the population. A potential limitation is the use of a dichotomised outcome for stress, as the category of ‘low/moderate stress’ is not subject to differentiation. However, the category of ‘high stress’, that is, scores >20 on a 0–40 scale, was the primary outcome of interest. A noteworthy strength includes the use of the ISCO classification system, as it is used internationally to accurately group occupations based on similarity of job tasks;—the Danish version of which is acquired through reliable registers from Statistics Denmark. Lastly, CPSS³⁵ shows robust psychometric properties across populations,^{33 34} and the Danish version further exhibits high reliability and validity across cultures.⁶⁶

CONCLUSION

Occupational groups characterised by mainly physical demanding work are more likely to experience daily pain and high stress, compared with occupations involving more sedentary work. Likewise, in this sample of senior workers, women exhibit increased odds of both daily pain and high stress, across occupations. These results provide incentive for future research to identify occupation-specific and sex-specific risk factors—especially among occupations with high physical demands—with the aim of informing company policies on how to prevent and manage musculoskeletal pain and psychosocial stress among senior workers.

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Data availability statement Data are available upon reasonable request. The authors encourage collaboration and use of data by other researchers. Data are stored on the server of Statistics Denmark, and researchers interested in using the data for scientific purposes should contact project leader Professor Lars L Andersen, lla@nfa.dk.

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